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## (54) Microfilm image scanner

(57) A microfilm image scanner for scanning an image on a microfilm 8 located in an aperture card 9 also containing punched holes 10 has a first light path formed by an optical assembly 3 and a transparent roller 7 adapted to form a focussed strip of light at a first location 11 for reading the microfilm. Images from the microfilm are projected via shutter aperture 13 onto a CCD scanning array 15. A further light path is formed via a mirror 20 and the roller 7 to read punched hole data 10 at a second location 21. Data from the punched holes are fed via fibre optic cables 22, lens 25 and shutter aperture 26 to the array 15. The punched hole data is read in one pass of the card and the microfilm data is read in a reverse pass direction of the card. The transparent roller 7 forms part of the optical and drive arrangement for reading both the microfilm and punched hole data and both sets of data are imaged onto the same array 15. A mechanical drive arrangement having low backlash and high repeatability is also described.

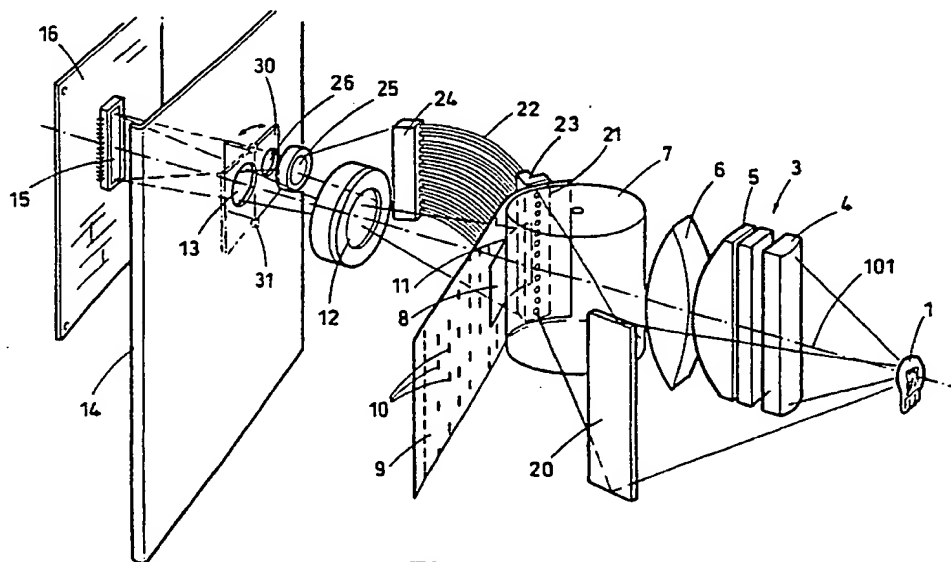


Fig. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1990.

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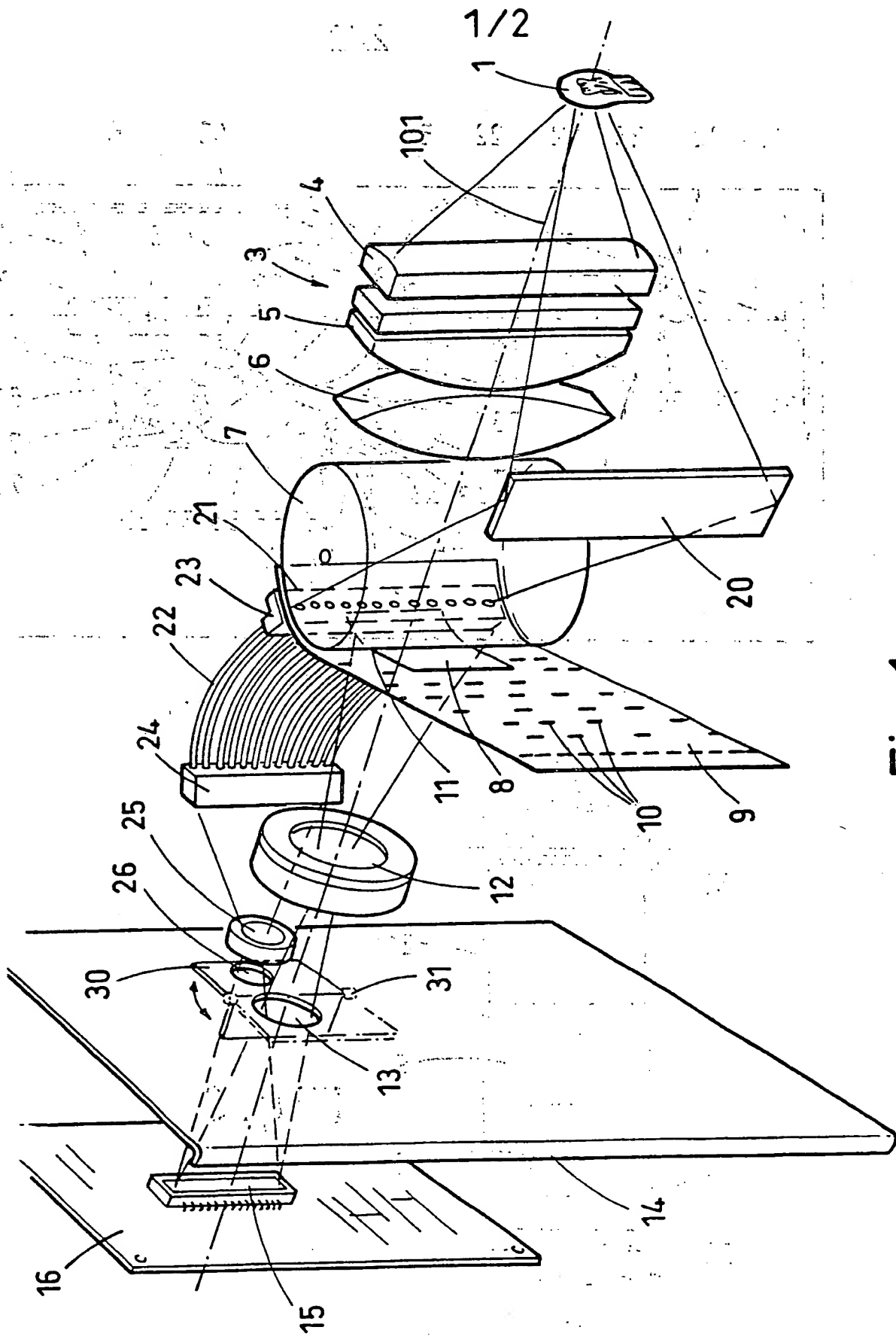


Fig. 1

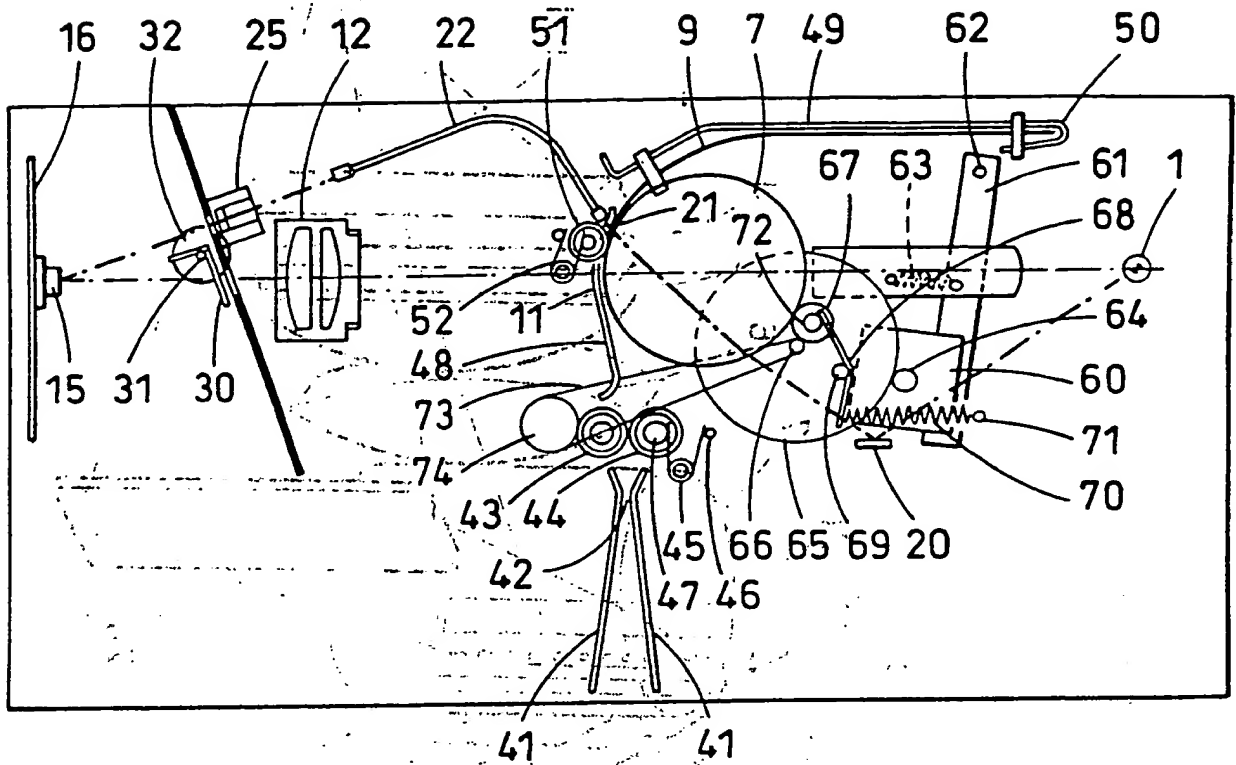


Fig. 2

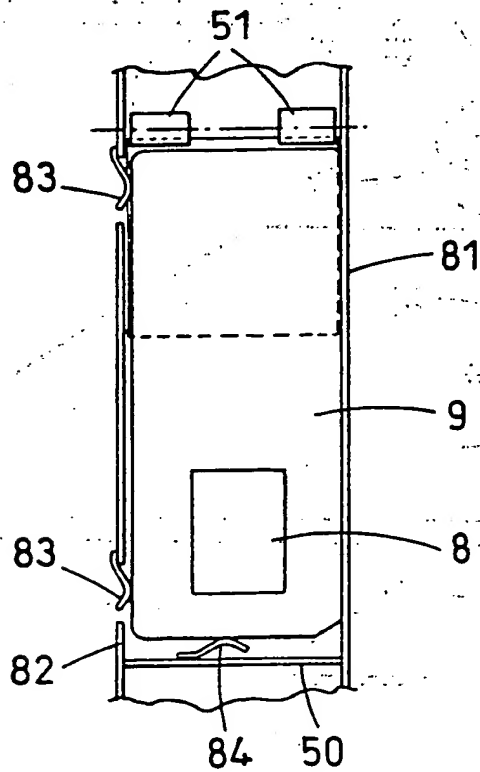


Fig. 3

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MICROFILM IMAGE SCANNER

This invention relates to a microfilm image scanner for scanning an image on a microfilm located in an aperture card.

5 It is known for aperture cards to contain a microfilm image representative of, for example, an engineering drawing or data and for the microfilm to be inserted into an aperture in the card. Such cards are usually rectangular in configuration and the microfilms are usually 10 35mm. The microfilm is usually positioned towards one end of the card and the remaining surface of the card normally contains a series of punched holes - known as Hollerith data - which represent data indicative of, for example, drawing identification, drawing size, date of generation, 15 etc.

Thus, when reading such an aperture card it is necessary to first of all read the Hollerith data represented by the punched holes and then to read the microfilm. Such microfilm image scanners usually feed 20 aperture cards from an input port through a first read scanner for reading the Hollerith data and thence to a second read scanner for reading the image information, the card then being outputted from a separate output port. Each of the read scanners has its own light path and 25 associated optics and a sensing array for reading the Hollerith data and another array for reading the microfilm image. The microfilm is driven through the scanner by a roller toward each of the two locations where the Hollerith and microfilm images are respectively read. Thus, the 30 roller drives the card toward one location where the Hollerith data is read and thence to a second location where the microfilm image data is read. As previously mentioned, each of the readers has its own optical system which, it will be appreciated, is expensive to produce. 35 It is an object of a first aspect of this invention to

produce a simplified optical system for reading microfilm in aperture cards.

According to a first aspect of this invention there is provided a microfilm image scanner for scanning an image on a microfilm located in an aperture card comprising an illuminating means associated with optical means for directing light over a light path through said microfilm onto a linear scannable array which is adapted to scan the image on said microfilm in one direction, and a transparent transportation roller means located in said light path and forming part of said optical means, wherein said roller means is adapted to transport said aperture card substantially orthogonally to said one direction and to focus said light on said microfilm at a first location so that the entire image on said microfilm may be scanned.

Preferably, said roller means is made of perspex<sup>(RTM)</sup> or glass.

Conveniently, said optical means comprises a pair of orthogonally arranged plano-convex cylindrical lenses and a bi-convex cylindrical lens serially mounted in said light path between said illuminating means and said roller means.

Preferably, a further optical means is located between said roller means and said array for focussing said image on said array.

In a preferred embodiment, means are provided for forming a further light path which is projected through said roller means toward a second location adjacent to said first location, and another optical means is provided between said roller means and said array for focussing images derived at said second location onto said array.

Conveniently, said further light path means comprise said illuminating means and a mirror.

Advantageously, the roller means is arranged to illuminate a strip of light at said first and second locations, the strip at said first location being wider than the microfilm image to be scanned, and the strip of

light at said second location at least approaching the width of said card.

Conveniently, said another optical means comprises a plurality of light fibres positioned to receive light  
5 through punched holes in said card and to direct images representative thereof onto said array.

In the preferred embodiment, because images from said further optical means and said light fibres each traverse a different optical path before being focussed onto said  
10 array, a shutter means is provided for selecting between each optical path.

Advantageously, said array is an electrically scannable linear charge coupled display (CCD) array.

Preferably, drive means is provided for bi-  
15 directionally driving said roller means.

Advantageously, feed means are provided for directing said cards to said roller means, and said feed means may be manually operable or supplied via a hopper for said cards.

Preferably, said drive means further includes a pair  
20 of pinch rollers for feeding said cards from said feed means to said roller means in a first direction of travel substantially orthogonal to said strip of light at said second location, whereby said punched holes may be successively illuminated in said first direction, and  
25 actuating means are provided for said shutter to permit images representative thereof only to be focussed onto said array, and in a second direction of travel, which is opposite to said first direction of travel, and substantially orthogonal to said strip of light at said  
30 first location, said image on said microfilm array may be illuminated, and at such a time said actuating means moves said shutter means so that only the image on said microfilm is focussed onto said array.

Advantageously, said drive means is a motor including  
35 a stepper motor for driving said roller means in discrete steps of, for example,  $2\mu\text{m}$  pitch when said microfilm is

being scanned by said array.

Preferably, said drive means includes gearing to drive said roller means at a slower peripheral speed than said pinch rollers so that said card is taut when travelling in said second direction and said microfilm is being scanned.

Advantageously, registration means are provided for ensuring accurate registration of said cards with respect to said light path prior to said card being driven in said second direction of travel. Conveniently, said registration means comprise spring means for directing an edge of said card toward a datum surface.

Because the prior microfilm image scanners utilize two separate sets of optics for reading the Hollerith data and the microfilm data respectively, so such scanners tend to be expensive to produce.

It is an object of a second aspect of this invention to at least partially mitigate this cost.

According to a second aspect of this invention, there is provided a microfilm image scanner for scanning an image on a microfilm located in an aperture card comprising a first light path means for directing light along a first light path to a first location, whereat an image of a microfilm may be illuminated, a second light path means for focussing said image at said first location along a second light path onto a scannable linear array, a third light path means for directing light along a third light path to a second location, whereat light may be directed through punched holes in said card to a fourth light path means for focussing data representative of said punched holes at said second location onto said scannable linear array, said first and third light path means including a common transparent drive roller means arranged to drive said cards past said first and second locations and to focus light from said first and third light path means at said first and second locations respectively.

Preferably, said drive roller means is driven bi-

directionally by a motor.

Advantageously, shutter means are provided between said array and said roller means, and means are provided for selectably moving said shutter means to block said second and fourth light paths respectively from being focussed onto said array.

In conventional microfilm image scanners the punched cards are driven from one input port and out of a second output port. Such arrangements lead to the forementioned increases in cost due to the additional optics required for the separate light paths for Hollerith data and microfilm image data and it is an object of a third aspect of this invention to at least partially mitigate this problem.

According to a third aspect of this invention there is provided a microfilm image scanner for scanning an image on a microfilm located on an aperture card comprising bi-directional drive means arranged to transport said cards past a reader means, whereby in one direction of travel the punched holes in said card are read by said reader means and, in a second direction of travel, the image on said microfilm is read by said reader means.

Preferably, said reader means comprises a first light path means for directing light along a first light path, to a first location, whereat an image of a microfilm may be illuminated, a second light path means for focussing said image at said first location along a second light path onto a scannable linear array, a third light path means for directing light along a third light path to a second location, whereat light may be directed through punched holes in said card to a fourth light path means for focussing data representative of said punched holes at said second location onto said scannable linear array, said first and third light path means including a common transparent drive roller means arranged to drive said cards past said first and second locations and to focus light from said first and third light path means at said first

and second locations respectively.

The use of such a bi-directional drive facilitates the use of a common input and output port and, in accordance with a fourth aspect of this invention, there is provided a  
5 microfilm image scanner for scanning an image on a microfilm located in an aperture card comprising feed means for transporting cards to and from a common input and output port for said cards; said feed means including a drive roller forming a part of an optical system for  
10 focussing at least one light path for reading said cards at a read station; and bi-directional drive means for driving said drive roller.

Preferably, said feed means also includes at least one pair of pinch rollers interposed between said common input  
15 and output port and said drive roller, said pinch rollers arranged to be driven by said drive means.

Preferably, said drive means comprises a stepper motor for driving said drive roller through first gearing means and for driving one of the rollers in the or each said at  
20 least one pair of pinch rollers through a second gearing means, whereby the speed of transportation of a card through said pinch rollers is greater than the speed of transportation of the card by said drive roller.

Advantageously, registration means are provided for  
25 ensuring accurate registration of said card with respect to the focus of said at least one light path prior to said card being driven in a reverse direction by said drive means toward said output port. Conveniently, said registration means comprise spring means for directing an  
30 edge of said card toward a datum surface.

In accordance with a fifth aspect of this invention, there is provided a method of operating a microfilm image scanner for scanning an image on a microfilm located in an aperture card comprising the steps of:

35 inserting said cards at an input port,  
transporting said cards to a first location where

Hollerith data on said cards is read by a linear scanning array, wherein optical means for focussing said image at said first location includes a card transportation roller which is transparent,

5 transporting said cards in a reverse direction of travel utilizing said roller, and focussing an image of said microfilm at a second location utilizing said transparent roller as part of the focussing arrangement, scanning said microfilm data with said array, and  
10 transporting said card to an output port which is common with said input port.

Preferably, said roller is driven in a step-wise fashion during scanning of said microfilm image.

The invention will now be described, by way of  
15 example, with reference to the accompanying drawings in which:-

Figure 1 shows a perspective diagrammatic view of the microfilm image scanner in accordance with this invention,

Figure 2 shows a plan view of the mechanical drive  
20 arrangement for the cards and part of the optical system, and

Figure 3 shows, in schematic form, a view  
perpendicular to the view of Figure 2 of an aperture card at its end limit of movement within the scanner in which  
25 some components are omitted for clarity.

In the Figures like reference numerals denote like parts.

The microfilm image scanner shown in Figure 1 has a lamp 1 for directing light over two light paths. The first  
30 longitudinally straight light path includes an optical system 3 formed in series by a plano-convex cylinder lens 4, a plano-convex cylinder lens 5 and a bi-convex cylindrical lens 6. The lenses 4 and 5 are arranged such that the convex cylinder lenses are in mutually orthogonal  
35 planes so that a strip of light is projected onto the surface of a transparent, rotatable, drive roller 7. The

roller 7, which may be of perspex or glass, is arranged to form part of the lens system of the first light path and focusses the strip of light, formed in a vertical direction in Figure 1, onto a microfilm 8 in an aperture card 9. The microfilm may be a 35mm film disposed such that the narrow direction of the film is in the vertical direction. The microfilm 8 is mounted in an aperture in the card 9 toward one end of the card and the remainder of the card is provided with a plurality of punched holes 10 which provide Hollerith data representative of, for example, drawing identification, drawing size, date of generation, etc. As shown in Figure 1, the roller 7 is mounted to have a vertical direction of rotation which intersects a longitudinal axis 101 of the first light path and is driven by a stepper motor 60 (not shown in Figure 1).

Thus, a narrow strip of light, for example  $7\mu\text{m}$  wide, and having a length slightly greater than the width of the microfilm 8, is formed at a first location 11. The image at the first location is projected via a main lens assembly 12 through an aperture 13 in a member 14 onto a linear, electrically scannable, charge coupled display (CCD) array 15 located on a printed circuit board 16, the array and printed circuit board being known per se for processing images. The array has, for example, 10,000 elements each on a  $7\mu\text{m}$  pitch and the projection ratio from the first location to the array may be 1:1 or 1.5:1.

A second light path is formed from the lamp 1 via a reflecting plain mirror 20 through the roller 7, where the path is refracted (as shown in Figure 2) to form a focussed image at a second location 21, in the form of a strip of light having a length approaching the width of the aperture card.

At the second location there is provided a vertical (as shown in Figure 1) array of fibre optical cables, there being one cable for each punched hole position in the height direction of the card. Thus, for example, if there

are 12 hole (Hollerith) positions in a vertical direction across the width of the card, then there are 12 fibre optic cables. The fibre optic cables 22 are held in a mounting block 23 to support one end of the cables and the other end of the fibre optic cables are located in a further block 24. Images from the cables in the block 24 are projected via a lens 25 through a further aperture 26 in the member 14 and, thence, onto the array 15. A selectably positionable shutter 30 is formed in an L-shape with the corner of the L-shape being mounted on an axle 31 such that the apertures 13 and 26 are selectively blocked by rotation of axle 31. By selectably rotating the shutter only light from the first location or the second location is able to fall upon the array 15.

By virtue of the transparent roller 7 acting not only as a drive for the card 9 through the first and second locations but also acting as part of the lens system, so a reduction in cost of the scanner is effected. Not only does the roller 7 have a dual function in this regard but it also is a common focussing element of the two light paths for focussing images at the first and second locations.

Referring to Figure 2 the axle 31 of the shutter is rotatably driven by a rotary solenoid 32. In the position shown in Figure 1, the light path from the second location via the fibre optic cables 22 is blocked from falling onto the array 15, whereas in the view of Figure 2 the image from the first location is prevented from falling upon the array 15.

The scanner has a common input and output port 40 defined by a pair of converging, then diverging, plates 41 to form a throat 42. A pair of pinch rollers 43, 44 are provided in alignment with the throat 42 and the roller 44 is biased toward the roller 43 by a coil spring 45 mounted such that one end of the coil spring is connected to a stop member 46 and the other end of the coil spring is mounted

to an axle 47 of the roller 44, the axle 47 having a small amount of lateral movement, whereas the locating axle of the roller 43 is fixedly mounted. A shaped guide plate 48 guides cards around the roller 7 toward a further guide plate 49, having an end remote from the roller 7 formed into a U-shape 50 to thereby act as an end stop for cards inserted into the scanner. A pair of rollers 51 are spaced in the longitudinal axial direction of the roller 7, as shown in Figure 3. The rollers 51 are biased by a coil spring 52, in similar manner to the bias on the roller 44, into contact with the transparent drive roller 7. The outer periphery of the rollers 51 may be provided with a resilient surface of, for example, elastomeric material for affording improved grip. The distance between the peripheral point contact between the rollers 51 and roller 7 and the end stop 50 is, preferably, just shorter than the length of an aperture card 9 so that when the drive roller 7 moves the card to the end stop 50 the card is slightly bowed and resilience in the card ensures that when the direction of rotation of the roller 7 is reversed, so the card is again picked up between the pinch of the rollers 51 and 7 to be driven through the pinch rollers 43, 44 and out of the common input and output port 40.

Drive for the roller 7 and the pinch rollers 43, 44 is derived from a stepper motor 60 located on an arm 61 which is pivoted about an axle 62 remote from the motor 60 and biased toward the roller 7 by a tension coil spring 63. An output shaft 64 of the stepper motor 60 drivingly contacts the outer periphery of a gear assembly formed by a roller 65 having a relatively large outside diameter and a shaft 66 on the axis of the roller 65, which shaft 66 has a relatively small outside diameter. The shaft 66 is connected by a further roller 67 having a larger diameter than the shaft 66, but smaller than the diameter of the roller 65, and the roller 67 also has an elastomeric outer surface for forming a good frictional engagement with the

shaft 66 and with the roller 7. The roller 67 is biased toward the shaft 66 and roller 7 by a bent arm 68 acting about a fulcrum 69, one end of the arm 68 being connected to a coil tension spring 70. The other end of the spring  
5 70 is connected to a stationary fixing 71, and the other end of the arm 68 abrades a reduced diameter of the portion 72 of the roller 67.

The shaft 66 is connected by a continuous drive belt 73 to a drive shaft 74 which drives the pinch roller 43  
10 and, thence, roller 44 so that the rollers 43, 44 rotate in contra-directions.

The gearing ratio of the shaft 64, shaft 66, roller 67 and roller 7, with respect to the gearing ratio of the shaft 64, the shaft 66, shaft 74 and pinch rollers 43, 44,  
15 is such that the speed of rotation of the periphery of the pinch rollers is greater than that of the drive roller 7. By such an expedient, when the card is being driven out of the scanning apparatus, the card is stretched taut between the pinch contact of the rollers 51, 7 and the pinch  
20 rollers 43, 44 so that the microfilm that is imaged at the first location 11 is not wrinkled.

As shown in Figure 3, the scanner, thus far described, is mounted in a chassis including two opposed side walls 81, 82. Because it is required that the microfilm, when it  
25 is scanned, be in precise registration with respect to the first location so that it can be read by the array 50, so it is necessary to ensure that an edge of the card, in which the microfilm is mounted, be in precise registration with the light beam focussed at the first location 11.

30 To accomplish such a requirement, a pair of leaf springs 83 are provided on the side wall 82 at spaced locations, near opposite ends of the card so that when the card is driven toward the end stop 50 by the roller 7, so the leaf springs 83 push the card down toward a datum  
35 surface formed by the side wall 81. If it should be found that the bow in the card 9, when it reaches the end stop

50, is insufficient for the card to be picked up by the rollers 51, 7 for return travel, so a further leaf spring 84 may be provided at the end stop 50 to assist the card in traversing the reverse direction.

5 In operation, aperture cards may be fed into the common input/output port 40 by hand or by a hopper (not shown). If a hopper is used then some means for separating cards entering the scanner from cards leaving the scanner will be required. Cards entering the throat 42 are pushed until they are picked up between the pinch rollers 43, 44 and are then fed to the confluence of the peripheries of the rollers 7 and 57. Thereby each card is driven through the second location 21 where the Hollerith data is read, utilizing lamp 1, mirror 20, transparent roller 7, fibre optic cables 22, lens 25 and array 15, and during which time the solenoid 31 is rotated so that the shutter 30 blocks the aperture 13. Because Hollerith data can be read quickly, due to the relative coarseness of the location of the punched holes, so the stepper motor is driven very rapidly to achieve what appears to be, to the eye, continuous motion. The card is driven by the roller 7 so that all the Hollerith data is read and until the card reaches the end stop 50 and, in passing toward the end stop 50, so the springs 83 push the card down to the datum surface provided by the side wall 81.

Due to the spring in the cards 9, so when the Hollerith data has been read the direction of rotation of the stepper motor is reversed and the drive roller 7 drives the card toward the first location 11. When driving the card toward the first location 11, the transport is again arranged to be rapid until the microfilm 8 is detected, whereupon the stepper motor is slowed down to provide time for the CCD scanner array 15 to read the image data on the microfilm. Thus, the microfilm is read by scanning a plurality of discrete lines. The pitch between the lines that are scanned at the first location determined by the

stepper motor and associated gearing may be in  $2\mu\text{m}$  steps.

The addressability of the stepper motor in an embodiment is approximately  $0.6\mu\text{m}$  and to achieve the desired high

reduction ratio between roller 7 and the stepper motor, so

15 a ratio of 125:1 may be employed. Thus, the microfilm is

read using lamp 1, lens assembly 12, roller 7, and the

solenoid 32 is rotated so that the shutter 30 closes the

aperture 26, opening aperture 13, and enabling the image

from the microfilm to be scanned by the array 15.

10 When the microfilm image has been completely scanned

then the time period of the steps of the stepper motor is

changed so that the card is rapidly driven between the

pinch rollers 43, 44 through throat 42 and out of the

common input/output port 40.

15 The mechanical arrangement of the present invention

has extremely low backlash and high repeatability. In the

prior art, the drive mechanisms tend to creep or "wind up"

when the drive apparatus is stopped, i.e. the drive

mechanism tends to advance when stopped even though no

20 drive is applied. Such creep or mechanical wind up is

virtually eliminated by the present invention so that high

repeatability is achieved. Such a feature is extremely

desirable since it is often required to stop and start the

drive mechanism during scanning.

CLAIMS:

1. A microfilm image scanner for scanning an image on a microfilm located in an aperture card comprising an illuminating means associated with optical means for directing light over a light path through said microfilm onto a linear scannable array which is adapted to scan the image on said microfilm in one direction, and a transparent transportation roller means located in said light path and forming part of said optical means, wherein said roller means is adapted to transport said aperture card substantially orthogonally to said one direction and to focus said light on said microfilm at a first location so that the entire image on said microfilm may be scanned.
2. A scanner as claimed in claim 1 wherein said roller means is made of perspex<sup>(R.T.M.)</sup> or glass.
3. A scanner as claimed in claim 2 wherein said optical means comprises a pair of orthogonally arranged plano-convex cylindrical lenses and a bi-convex cylindrical lens serially mounted in said light path between said illuminating means and said roller means.
4. A scanner as claimed in any preceding claim wherein a further optical means is located between said roller means and said array for focussing said image on said array.
5. A scanner as claimed in claim 4 wherein means are provided for forming a further light path which is projected through said roller means toward a second location adjacent to said first location, and another optical means is provided between said roller means and said array for focussing images derived at said second location onto said array.

6. A scanner as claimed in claim 5 wherein said further light path means comprise said illuminating means and a mirror.

7. A scanner as claimed in claim 6 wherein the roller means is arranged to illuminate a strip of light at said first and second locations, the strip at said first location being wider than the microfilm image to be scanned, and the strip of light at said second location at least approaching the width of said card.

8. A scanner as claimed in any of claims 5 to 7 wherein said another optical means comprises a plurality of light fibres positioned to receive light through punched holes in said card and to direct images representative thereof onto said array.

9. A scanner as claimed in claim 8 wherein a shutter means is provided for selecting between each optical path.

10. A scanner as claimed in any preceding claim wherein said array is an electrically scannable linear charge coupled display (CCD) array.

11. A scanner as claimed in any preceding claim wherein drive means is provided for bi-directionally driving said roller means.

12. A scanner as claimed in any preceding claim wherein feed means are provided for directing said cards to said roller means, and said feed means may be manually operable or supplied via a hopper for said cards.

13. A scanner as claimed in claim 12 wherein said drive means further includes a pair of pinch rollers for feeding said cards from said feed means to said roller means in a

first direction of travel substantially orthogonal to said strip of light at said second location, whereby said punched holes may be successively illuminated in said first direction, and actuating means are provided for said shutter to permit images representative thereof only to be focussed onto said array, and in a second direction of travel, which is opposite to said first direction of travel, and substantially orthogonal to said strip of light at said first location, said image on said microfilm array may be illuminated, and at such a time said actuating means moves said shutter means so that only the image on said microfilm is focussed onto said array.

14. A scanner as claimed in claim 13 wherein said drive means is a motor including a stepper motor for driving said roller means in discrete steps of, for example, 2 $\mu$ m pitch when said microfilm is being scanned by said array.

15. A scanner as claimed in claim 14 wherein said drive means includes gearing to drive said roller means at a slower peripheral speed than said pinch rollers so that said card is taut when travelling in said second direction and said microfilm is being scanned.

16. A scanner as claimed in any preceding claim wherein registration means are provided for ensuring accurate registration of said cards with respect to said light path prior to said card being driven in said second direction of travel.

17. A scanner as claimed in claim 16 wherein said registration means comprise spring means for directing an edge of said card toward a datum surface.

18. A microfilm image scanner for scanning an image on a microfilm located on an aperture card comprising bi-

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directional drive means arranged to transport said cards past a reader means, whereby in one direction of travel the punched holes in said card are read by said reader means and, in a second direction of travel, the image on said microfilm is read by said reader means.

19. A scanner as claimed in claim 18 wherein said reader means comprises a first light path means for directing light along a first light path, to a first location, whereat an image of a microfilm may be illuminated, a second light path means for focussing said image at said first location along a second light path onto a scannable linear array, a third light path means for directing light along a third light path to a second location, whereat light may be directed through punched holes in said card to a fourth light path means for focussing data representative of said punched holes at said second location onto said scannable linear array, said first and third light path means including a common transparent drive roller means arranged to drive said cards past said first and second locations and to focus light from said first and third light path means at said first and second locations respectively.

20. A scanner substantially as herein described with reference to and as shown in the accompanying drawings.

Amendments to the claims have been filed as follows

1. A microfilm image scanner for scanning an image on a microfilm located in an aperture card comprising an illuminating means associated with optical means for directing light over a light path through said microfilm onto a linear scannable array which is adapted to scan the image on said microfilm in one direction, and a transparent transportation roller means located in said light path and forming part of said optical means, wherein said roller means is adapted to transport said aperture card substantially orthogonally to said one direction and to focus said light on said microfilm at a first location so that the entire image on said microfilm may be scanned.

2. A scanner as claimed in claim 1 wherein said roller means is made of perspex or glass.

3. A scanner as claimed in claim 2 wherein said optical means comprises a pair of orthogonally arranged plano-convex cylindrical lenses and a bi-convex cylindrical lens serially mounted in said light path between said illuminating means and said roller means.

4. A scanner as claimed in any preceding claim wherein a further optical means is located between said roller means and said array for focussing said image on said array.

5. A scanner as claimed in claim 4 wherein means are provided for forming a further light path which is projected through said roller means toward a second location adjacent to said first location, and another optical means is provided between said roller means and said array for focussing images derived at said second location onto said array.

6. A scanner as claimed in claim 5 wherein said further light path means comprise said illuminating means and a mirror.
7. A scanner as claimed in claim 6 wherein the roller means is arranged to illuminate a strip of light at said first and second locations, the strip at said first location being wider than the microfilm image to be scanned, and the strip of light at said second location at least approaching the width of said card.
8. A scanner as claimed in any of claims 5 to 7 wherein said another optical means comprises a plurality of light fibres positioned to receive light through punched holes in said card and to direct images representative thereof onto said array.
9. A scanner as claimed in claim 8 wherein a shutter means is provided for selecting between each optical path.
10. A scanner as claimed in any preceding claim wherein said array is an electrically scannable linear charge coupled display (CCD) array.
11. A scanner as claimed in any preceding claim wherein drive means is provided for bi-directionally driving said roller means.
12. A scanner as claimed in any preceding claim wherein feed means are provided for directing said cards to said roller means, and said feed means may be manually operable or supplied via a hopper for said cards.
13. A scanner as claimed in claim 12 wherein said drive means further includes a pair of pinch rollers for feeding said cards from said feed means to said roller means in a first direction of travel substantially orthogonal to said

strip of light at said second location, whereby said punched holes may be successively illuminated in said first direction, and actuating means are provided for said shutter to permit images representative thereof only to be focussed onto said array, and in a second direction of travel, which is opposite to said first direction of travel, and substantially orthogonal to said strip of light at said first location, said image on said microfilm array may be illuminated, and at such a time said actuating means moves said shutter means so that only the image on said microfilm is focussed onto said array.

14. A scanner as claimed in claim 13 wherein said drive means is a motor including a stepper motor for driving said roller means in discrete steps of, for example,  $2\mu\text{m}$  pitch when said microfilm is being scanned by said array.

15. A scanner as claimed in claim 14 wherein said drive means includes gearing to drive said roller means at a slower peripheral speed than said pinch rollers so that said card is taut when travelling in said second direction and said microfilm is being scanned.

16. A scanner as claimed in any preceding claim wherein registration means are provided for ensuring accurate registration of said cards with respect to said light path prior to said card being driven in said second direction of travel.

17. A scanner as claimed in claim 16 wherein said registration means comprise spring means for directing an edge of said card toward a datum surface.

18. A microfilm image scanner for scanning an image on a microfilm located on an aperture card comprising bi-directional drive means arranged to transport said cards past a reader means, whereby in one direction of travel the

punched holes in said card are read by said reader means and, in a second direction of travel, the image on said microfilm is read by said reader means.

19. A scanner as claimed in claim 18 wherein said reader means comprises a first light path means for directing light along a first light path, to a first location, whereat an image of a microfilm may be illuminated, a second light path means for focussing said image at said first location along a second light path onto a scannable linear array, a third light path means for directing light along a third light path to a second location, whereat light may be directed through punched holes in said card to a fourth light path means for focussing data representative of said punched holes at said second location onto said scannable linear array, said first and third light path means including a common transparent drive roller means arranged to drive said cards past said first and second locations and to focus light from said first and third light path means at said first and second locations respectively.

20. A microfilm image scanner for scanning an image on a microfilm located in an aperture card comprising a first light path means for directing light along a first light path to a first location, whereat an image of a microfilm may be illuminated, a second light path means for focussing said image at said first location along a second light path onto a scannable linear array, a third light path means for directing light along a third light path to a second location, whereat light may be directed through punched holes in said card to a fourth light path means for focussing data representative of said punched holes at said second location onto said scannable linear array, said first and third light path means including a common transparent drive roller means arranged to drive said cards past said first and second locations and to focus light

from said first and third light path means at said first and second locations respectively.

21. A scanner as claimed in claim 20 wherein said drive roller means is driven bi-directionally by a motor.

22. A scanner as claimed in claim 21 wherein shutter means are provided between said array and said roller means, and means are provided for selectably moving said shutter means to block said second and fourth light paths respectively from being focussed onto said array.

23. A microfilm image scanner for scanning an image on a microfilm located in an aperture card comprising feed means for transporting cards to and from a common input and output port for said cards, said feed means including a drive roller forming a part of an optical system for focussing at least one light path for reading said cards at a read station, and bi-directional drive means for driving said drive roller.

24. A scanner as claimed in claim 23 wherein said feed means also includes at least one pair of pinch rollers interposed between said common input and output port and said drive roller, said pinch rollers arranged to be driven by said drive means.

25. A scanner as claimed in claim 24 wherein said drive means comprises a stepper motor for driving said drive roller through first gearing means and for driving one of the rollers in the or each said at least one pair of pinch rollers through a second gearing means, whereby the speed of transportation of a card through said pinch rollers is greater than the speed of transportation of the card by said drive roller.

26. A scanner as claimed in claim 25 wherein

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registration means are provided for ensuring accurate registration of said card with respect the focus of said at least one light path prior to said card being driven in a reverse direction by said drive means toward said output  
5 port.

27. A scanner as claimed in claim 26 wherein said registration means comprise spring means for directing an edge of said card toward a datum surface.

28. A method of operating a microfilm image scanner for  
10 scanning an image on a microfilm located in an aperture card comprising the steps of:

inserting said cards at an input port,  
transporting said cards to a first location where  
Hollerith data on said cards is read by a linear scanning  
15 array, wherein optical means for focussing said image at said first location includes a card transportation roller which is transparent,  
transporting said cards in a reverse direction of travel utilizing said roller, and focussing an image of  
20 said microfilm at a second location utilizing said transparent roller as part of the focussing arrangement,  
scanning said microfilm data with said array, and  
transporting said card to an output port which is common with said input port.

25 29. A method as claimed in claim 28 wherein said roller is driven in a step-wise fashion during scanning of said microfilm image.

30. A scanner substantially as herein described with reference to and as shown in the accompanying drawings.

30 31. A method as claimed in claim 28 and substantially as herein described with reference to and as shown in the accompanying drawings.

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**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Application number

GB 9219435.6

**Relevant Technical fields**

(i) UK Cl (Edition 1) G2J (JB7W9, JB7WX);  
H4F (FCA, EJS)

(ii) Int Cl (Edition 5) G02B

**Search Examiner**

R E HARDY

**Databases (see over)**

(i) UK Patent Office

(ii) WPI

**Date of Search**

16 MARCH 1993

Documents considered relevant following a search in respect of claims 1-17, 19, 20

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	US 4928140 A (WISE)	-



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**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
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Application number

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**Relevant Technical fields**

(i) UK CI (Edition L ) G2J (JB7W9, JB7WX); G4M (MBB);  
H4F (FAA, FCA, FDB, FDC)

(ii) Int CI (Edition 5 ) GO2B

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**Date of Search**

16 MARCH 1993

Documents considered relevant following a search in respect of claims 18

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

Category	Identity of document and relevant passages - 27 -	Relevant to claim(s)
	<p>1. A method of determining the relative positions of two points in a three-dimensional space, comprising the steps of:</p> <p>a) determining the coordinates of the two points in a three-dimensional space;</p> <p>b) determining the relative positions of the two points in a three-dimensional space;</p> <p>c) determining the relative positions of the two points in a three-dimensional space;</p> <p>d) determining the relative positions of the two points in a three-dimensional space;</p> <p>e) determining the relative positions of the two points in a three-dimensional space;</p> <p>f) determining the relative positions of the two points in a three-dimensional space;</p> <p>g) determining the relative positions of the two points in a three-dimensional space;</p> <p>h) determining the relative positions of the two points in a three-dimensional space;</p> <p>i) determining the relative positions of the two points in a three-dimensional space;</p> <p>j) determining the relative positions of the two points in a three-dimensional space;</p> <p>k) determining the relative positions of the two points in a three-dimensional space;</p> <p>l) determining the relative positions of the two points in a three-dimensional space;</p> <p>m) determining the relative positions of the two points in a three-dimensional space;</p> <p>n) determining the relative positions of the two points in a three-dimensional space;</p> <p>o) determining the relative positions of the two points in a three-dimensional space;</p> <p>p) determining the relative positions of the two points in a three-dimensional space;</p> <p>q) determining the relative positions of the two points in a three-dimensional space;</p> <p>r) determining the relative positions of the two points in a three-dimensional space;</p> <p>s) determining the relative positions of the two points in a three-dimensional space;</p> <p>t) determining the relative positions of the two points in a three-dimensional space;</p> <p>u) determining the relative positions of the two points in a three-dimensional space;</p> <p>v) determining the relative positions of the two points in a three-dimensional space;</p> <p>w) determining the relative positions of the two points in a three-dimensional space;</p> <p>x) determining the relative positions of the two points in a three-dimensional space;</p> <p>y) determining the relative positions of the two points in a three-dimensional space;</p> <p>z) determining the relative positions of the two points in a three-dimensional space;</p>	

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